

**REMARKS**

Claims 1, 4-11 and 13-23 are pending in this application.

The Office Action rejects claims 1, 4-7, 11, 13, 15, and 18-23 under 35 U.S.C.

§103(a) over U.S. Patent No. 6,593,159 to Hashimoto et al. (Hashimoto) in view of U.S. Patent No. 6,239,033 to Kawai, newly cited U.S. Patent No. 6,413,839 to Brown, and CRC Handbook of Chemistry and Physics, 82<sup>nd</sup> Ed. by David Lide (Lide). This rejection is respectfully traversed.

In determining obviousness, the question under 35 U.S.C. §103 is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983). The Office Action fails to do so. Moreover, when considering a prior art reference, the Patent Office must consider the reference in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. *W.L. Gore & Assoc. Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984). The Office Action also fails to do this because the Examiner has summarily dismissed Applicants' prior arguments that show that the references "as a whole" teach away from the alleged combination. Instead, the Examiner is impermissibly relying on hindsight consideration of Applicants' specification to "pick and chose" individual elements while ignoring express teachings that would lead away from the combination and modifications alleged. However, the teaching and suggestion to combine and the reasonable expectation of success must both be found in the prior art, and not based on Applicants' disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).<sup>1</sup>

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<sup>1</sup> The decision on patentability must be based on a totality of the evidence. Facts established by rebuttal evidence must be evaluated along with the facts on which the conclusion of obviousness was reached, not against the conclusion itself. *In re Eli Lilly & Co.*, 902 F.2d 943, 14 USPQ2d 1741 (Fed. Cir. 1990). As discussed above, much of Applicants' rebuttal argument was summarily dismissed without comment.

In particular, the Office Action admits that Hashimoto fails to teach filling of the cavity 68 with a material having a greater thermal conductivity than the body as recited in independent claim 1. The Office Action alleges that it would have been obvious to substantially fill Hashimoto's empty cavity recess 68 with a material having a greater thermal conductivity than the sapphire substrate body, based on the teachings of Kawai, alleging that Kawai teaches that the Au filing permits heat generated to be radiated to Au film 37 (located under the Sapphire layer)(Col. 11, lines 36-40). Applicants again respectfully disagree and assert that this feature is "picked" from Kawai without considering the teachings of Kawai and in Hashimoto "as a whole," which would teach against the combination as alleged.

As argued previously, the purpose of Hashimoto is to decrease threading dislocations and cracks inside the semiconductor device structure so as to lengthen the lifetime of the device. To achieve this goal, an empty recess/cavity is formed within a thick sapphire substrate, opening toward the bottom of the surface, so that the thickness of the sapphire substrate 100 is set smaller than or substantially equal to the thickness of the semiconductor layer GaN layer 103 in device forming areas (C3/L10-17 and C3/L38-51).

The empty recess/cavity 68 in Hashimoto is critical to its operation to achieve a substrate thickness in the device forming areas (under the electrodes) that is not thicker than the GaN layer thickness. Therefore, Hashimoto when read "as a whole" teaches away from filling the cavity with any kind of material as alleged, as this would increase the thickness to more than the thickness of the GaN layer and presumably increase cracks from different thermal expansion coefficients (a problem recognized by Hashimoto on C1/L49-55). Thus, the Patent Office has failed to fully consider Hashimoto "as a whole" and failed to address this rebuttal "teaching away" evidence, as required by MPEP §2142.02(VI).

Moreover, to proceed as the Office Action suggests would obviate the main purpose of Hashimoto, rendering it unsuitable for its intended purpose, which is to provide a device

with reduced cracking density a threading dislocation due to differences in thermal coefficients of expansion (see object on C2/L56-60). As set forth in MPEP §2143.01(VI), such impermissible modifications do not render a combination *prima facie* obviousness. Thus, because there is no motivation or suggestion to combine the references as alleged from the Hashimoto teachings, the requirements for a *prima facie* case of obviousness have not been met.

Kawai fails to overcome the deficiencies of Hashimoto with respect to independent claim 1. Kawai does not, in context, teach advantages to filling a cavity for heat conduction as alleged, and clearly does not teach or suggest use of a very large cavity as claimed.

Instead, Kawai teaches advantages to "thinning" of the sapphire substrate, preferably to less than 100  $\mu\text{m}$ , to improve heat dissipation (C1/L35-C2/L47, C3/L47-58, and C11/L4-18 and 35-40). Kawai then places a heat sink layer 37 of Au 37 below the entire sapphire layer.

Contrary to assertions in the Office Action, improved heat dissipation in Kawai is attributed to the "thin-ness" of the sapphire layer at C11/L35-40 where it states "since the thinned sapphire substrate 21 permits heat to be radiated well to the Au film 37 behaving as a heat sink, increase in temperature of the GaN FET 23 can be alleviated" (emphasis added). Thus, contrary to the assertion in the Office Action, heat dissipation is taught to be improved by the use of a thin sapphire layer, not through the small via hole 35 filled with Au. Rather, the sole purpose of the small via hole 35 in Kawai is such that the Au pad 37 (below the sapphire layer) can be "electrically connected from the substrate bottom side to the Au pad as the source pad through the via hole 35 formed in the sapphire substrate 21" (C11/L12-18 and Fig. 11).

Thus, like Hashimoto, Kawai teaches that the area under the semiconductor device (in fact the whole sapphire layer) should be thin. Additionally, to improve heat dissipation,

Kawai teaches to provide a large heatsink layer 37 of Au underneath the entire sapphire substrate. This, when read "as a whole" and in context, also teaches away from the subject matter of independent claim 1, which can use a thick sapphire substrate (for improved structural support) and a large cavity filled with a material of greater thermal conductivity (for heat dissipation). It also teaches away from combination with Hashimoto as it shows that a heat sink can be provided under the sapphire layer.

Brown fails to overcome the deficiencies of Hashimoto and Kawai with respect to independent claim 1.

Lide is only relied upon for identification of gold (Au) as having high thermal conductivity properties. However, Lide fails to appreciate problems overcome by the subject matter of claim 1 and fails to overcome deficiencies of Hashimoto and Kawai with respect to independent claim 1.

Accordingly, independent claim 1 and the claims dependent therefrom define over the alleged combination and are allowable.

With respect to independent claim 22, the Office Action fails to address each and every feature of claim 22. In particular, claim 22 specifies that the cavity "opens to the bottom without opening onto the top surface." The Office Action admits that Hashimoto has no material of greater thermal conductivity filling its cavity. Kawai teaches use of a heatsink layer of Au film 37 below a thin sapphire substrate. Kawai also teaches a requirement of the small via hole 35 and Au in order to achieve electrical connection. Thus, Kawai when "read as a whole" teaches away from combination with a thick sapphire substrate having a large cavity that does not open onto the top surface (as this would prevent electrical connection). Additionally, because of Kawai's teachings that the "thin-ness" of the sapphire layer to less than 100  $\mu\text{m}$  can improve heat dissipation to the heatsink layer 37, Kawai, if anything teaches

away from the subject matter of claim 22 and teaches away from forming a large cavity in an otherwise thick sapphire substrate.

Although Kawai recognizes possible problems with warping due to thinning of the sapphire layer, Kawai teaches specific thinning procedures that appear to address such a problem. Thus, Kawai fails to appreciate the advantage in structural rigidity that can be achieved by use of a thicker (and harder) sapphire layer in areas other than where the semiconductor devices are being formed. Accordingly, Kawai is not combinable with Hashimoto and, even if combined, fails to teach or suggest each and every feature of independent claim 22. Accordingly, independent claim 22 defines over the alleged combination and is allowable.

Dependent claim 23 adds that the body thickness is at least about 100  $\mu\text{m}$ . This is supported, for example, by paragraph [0006] and Fig. 16. As mentioned above with respect to claim 1, Kawai teaches advantages to "thinning" of the substrate to be less than 100  $\mu\text{m}$ , and fails to appreciate the advantage in structural rigidity afforded by use of a thicker sapphire layer. Thus, although Hashimoto may have a thick sapphire layer, Hashimoto teaches use of a thin sapphire layer under the device forming area through use of an empty cavity. Kawai teaches away from combination with Hashimoto because, when read as a whole, Kawai teaches an advantage in heat dissipation to a heat sink located under the sapphire through use of a thin sapphire layer. Accordingly, claim 23 is allowable for its dependence on base claim 1 and for the additional features recited therein.

Withdrawal of the rejection is respectfully requested.

The Office Action rejects claims 8-9 under 35 U.S.C. §103(a) over Hashimoto in view of Kawai, Brown and Lide, further in view of U.S. Patent No. 5,731,046 to Mistry et al. This rejection is respectfully traversed.

Mistry fails to overcome the deficiencies of Hashimoto and Brown with respect to independent claim 1. Accordingly, claims 8-9 are allowable for their dependence on allowable base claim 1 and for the additional features recited therein. Withdrawal of the rejection is respectfully requested.

The Office Action rejects claim 10 under 35 U.S.C. §103(a) over Hashimoto in view of Kawai, Brown and Lide, further in view of U.S. Patent No. 6,189,771 to Maeda. This rejection is respectfully traversed.

Maeda fails to overcome the deficiencies of Hashimoto et al. with respect to independent claim 1. Accordingly, claim 10 is allowable for its dependence on allowable base claim 1 and for the additional features recited therein. Withdrawal of the rejection is respectfully requested.

The Office Action rejects claims 14 and 16-17 under 35 U.S.C. §103(a) over Hashimoto in view of Kawai, Brown and Lide, further in view of U.S. Patent No. 5,449,930 to Zhou. This rejection is respectfully traversed.

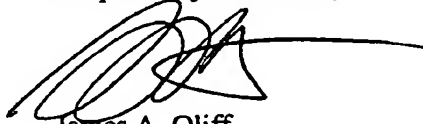
Zhou fails to overcome the deficiencies of Hashimoto, Kawai and Brown with respect to independent claim 1. Zhou is relied upon for having a cavity with a depth equal to the thickness of the body. However, the Office Action fails to provide a motivation for replacing the isolated cavity in Hashimoto with a structure in Zhou that has a through opening. Moreover, Zhou is directed to a GaAs structure, not a sapphire body. Sapphire is a much harder substrate with different properties. Also, as mentioned previously, the empty cavity 68 in Hashimoto is specifically provided to prevent thread dislocations. Thus, Hashimoto teaches a criticality to the empty cavity, which is incompatible with the structure in Zhou. Zhou is not made of a hard substance such as sapphire and thus does not face the same problems faced by Hashimoto. Accordingly, one of ordinary skill in the art would not have been led to combine Zhou with Hashimoto as alleged. Thus, claims 14 and 16-17 are

allowable for their dependence on allowable base claim 1 and for the additional features recited therein. Withdrawal of the rejection is respectfully requested.

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of pending claims are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,



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